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(54) **Feed premix and production method therefor.**

(57) A relatively dry, thermally stable, feed premix comprising a pelletized mixture of a physiologically acceptable carrier, for example, a grain flour, and one or more enzymes, is produced by mixing the ingredients, reacting the mixture to absorb the enzyme or enzymes into the carrier, and pelletizing the reacted mixture.

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Description

FEED PREMIX AND PRODUCTION METHOD THEREFOR

This invention relates to a feed premix and to a method for producing such a premix.

The use of enzymes to treat animal feed mixes is well known. The treatment of animal feed mixes with enzymes can improve the digestibility of the feed and hence making the feed more efficient and increase its energy content. For example, U.S. Patents 2,988,949 and 2,988,448 (Hollenbeck) describe the treatment of raw barley feed with barley malt containing cytolytic enzymes; it is reported that poultry fed with the treated feed showed improved growth rate because of the increased energy value of the feed. In general, enzymes act to break down feed products, thus increasing the availability of digestible components in the feed to the animal.

However, despite the numerous advantages enzymes have as feed additives, their use in feeds is limted by several drawbacks. One particular problem is the heat instability of most enzymes; the heated conditions which most feed processing takes place inactivates any enzymes present. Moreover, the amounts of enzymes which need to be added are extremely small, which makes effective and uniform mixing a serious problem. The difficulty in utilizing enzymes as a feed ingredient is also exacerbated by the fact that most commercial enzymes products are enzyme solutions which are more difficult to mix then dry ingredients.

One possible solution to these problems is the utilization of pre-mix. Because ingredients such as antibiotics, vitamins, minerals and the like are added to the feed in small quantities, they cannot be added directly to the feed because uniform distribution would be impossible in the context of commercial feed production. A premix consisting of a carrier and active ingredients is generally utilized to introduce these "micro-ingredients" into the feed. United States Patent 4,218,437 (Hiller) discloses the use of a feed premix wherein the active ingredients consist of antibiotics in combination with certain enzymes. However, it is not disclosed or suggested that the premix discussed could be effectively and efficiently utilized in the large scale commercial production or feed.

Feed premixes - for effective utilization in commercial feed processing - must have certain properties including, inter alia, physical stability, non-interference with the chemical stability of the active product, and good flow and blending properties. To date, no such feed premix containing enzymes has been available for large scale use.

In sum, it has not been simple or cost effective to use enzymes as a feed additive on a large commercial scale.

The present invention accordingly provides a relatively dry, thermally stable, premix which comprises a physiologically acceptable carrier and one or more enzymes. The carrier consists of a physiologically acceptable feed ingredient which is compatible with the active enzyme ingredients; preferred carriers include grain flours such as wheat and barley.

The invention will thus be understood to provide for a relative dry, thermally stable premix which contains one or more enzymes which can be utilized for commercial feed processing. The premix has a high enzyme activity which is not significantly affected by high temperatures used in feed processing. The premix has good flow properties and can be easily and uniformly blended into a feed mixture to effectively improve the properties of the feed.

The invention also provides a method for making a feed premix by mixing a physiologically acceptable carrier with one or more enzymes, and reacting the mixture so that the enzyme or enzymes are substantially absorbed into the carrier. The resulting product is then pelletized, dried and milled. The premix product preferably has a moisture content of less than about 10%. The enzyme can be added as a dry ingredient or as part of an enzyme solution.

It is an advantage of the present invention that it allows enzyme solutions to be used in place of dry products. Enzyme solutions are generally cheaper than corresponding dry products contributing to the overall price efficiency of the instant method. This method produces an enzyme premix which is thermally stable and does not exhibit any significant degradation of the enzymes at feed processing temperatures.

It has been found that the stability of enzymes in feed processing is greatly increased by the preparation of an enzyme premix wherein the enzyme is absorbed onto a carrier consisting of flour or other similar material, and pelletized. The resulting thermally stable premix has good flow properties and can be easily blended into a feed mixture to final concentrations of about 0.01-0.5% by weight. The premix can be easily blended into feed in amounts of less than 5 kg premix per ton of feed. The carrier is preferably prepared from a suitable, natural starch-containing material such as grain or flour and typically the carrier may itself contain several active enzymes.

Pelletizing the enzyme/carrier improves the thermal stability of the active enzyme or enzyme ingredients present. Pelletization also makes it possible to dry the premix product to a water content below about 30% by weight; preferably the water content is between about 7% and about 15% by weight with a particularly preferred water content of less than about 10% by weight. Drying of the premix in the context of this invention does not significantly denature or deactivate the enzyme or enzymes present. The pelletized premix is easily dried by warm air at a temperature below 65°C, preferably below 45°C. The dried pellets can be crushed or milled before mixing with the final feed mixture.

The premix contains an enzyme and/or enzyme combinations which improve the qualities of the feed mixture. Such enzymes include, inter alia, starch hydrolyzing enzymes or amylases, cellulose hydrolyzing

enzymes or cellulases, cellulose hydrolyzing enzymes or cellulases and hemicellulases, glucanases, lipases, proteinases and the like. In particular, suitable enzymes include cellulases from Thricoderma reesei or proteases from Bacillus subtilis, which are usually marketed as enzyme solutions, or dry products like the alfa-amylase prepared from Bacillus subtilis. The enzymes are generally present in a liquid form although dried enzyme product can also be utilized.

The carrier material can be any physiologically acceptable feed ingredient which is compatible with the active enzyme ingredients. The preferred carrier material is a suitable flour product which permits an enzyme solution to be mixed with the carrier without drying of the enzyme. If an enzyme solution is utilized, additional water does not generally need to be added prior to pelletization because the enzyme-water solution provides the required moisture. Of course, dry enzymes can also be added to the mixture, along with water, instead of or in addition to enzyme solutions.

Suitable carriers include starch containing flours, for example wheat, barley or other grain flour, which have water contents of less than about 15% by weight, with a preferable water content of about 12% to about 14%. The carrier generally comprises between about 40% to about 99% by weight of the premix with a preferable concentration between about 40% to about 90%. The enzyme or enzymes generally comprise about 1% to about 60% of the premix by weight, with a preferable content of about 10% to about 40%.

The invention is further described below, by way of example, with reference to the accompanying drawing, the single figure of which schematically depicts a preferred form of apparatus which can be used for large scale commercial production of an enzyme feed premix in accordance with the present invention.

The illustrated apparatus comprises an effective and efficient production line for the preparation of an enzyme premix. Carrier materials withdrawn from storage silos 1 and 1′ are weighed on balances 2 and 2′, and transferred to a mixer 3. A transporter 4 transfers the mixed carrier materials to a storage silo 5. From the storage silo 5, the carrier materials are transferred to a balance 6 and weighed together with dry enzyme products.

Enzyme solutions are stored in tanks 8 and are transferred in the appropriate amount or amounts to a mixer 9 for mixing. A suitable mixer is a continuous type mixer, for example, an Amandus Kahl "Durchlaufmischer Grosse Type 12 III" or similar device. Steam is supplied to the mixer 9 if necessary to increase the moisture content of the mix. From the mixer 9 the enzyme-carrier mixture is transferred to a reaction tank 10 where the enzymes are absorbed into the carrier material. A suitable reaction tank is an Amandus Kahl type LK 2210-2 tank or a similar device, which is equipped with an agitator. The mixture remains in the absorption tank 10 for 10-60 minutes, typically for approximately 30 minutes.

Thereafter the mixture is fed to a suitable pelletizing device 11 for example, an Amandus Kahl types 35-780 pelletizer (or similar collar-type device) where the material is pressed through a matrix and the formed stripes are cut into suitable pellets with a length of approximately 15 mm and diameter of about 5-8 mm. The moisture of the mass when arriving into the pelletizing machine is generally between about 18% and about 19% and the temperature is kept below about 60°C, preferably below about 45°C.

After pelletization the product is dried with warm air in a drying medium 12 such as an Amandus Kahl 275-04 band-drier or a similar drying device. Finally the product is cooled in a cooler 13 so that the final moisture content is approximately 8%. The dry, cool pellets can be milled or crushed in a crusher 14. Oversize particles are returned from the crusher 14 and the product is transferred to storage silos 15. The product may be finally treated in a centrifugal machine 16 which disintegrates the particles and homogenizes the product. A suitable device for this purpose is the Simon Entoleter Standard IMP 590 "sentry impact infestation destroyer" or similar devices. The resulting product is ready for packaging and shipping.

The enzyme premix prepared by this method exhibits thermal stability and is free flowing, easy to handle and easily blended. The low moisture content of the premix - preferably less than about 10% by weight-contributes to these properties. In addition, the process outlined above results in a premix with a relatively high enzymatic activity, because the methods employed do not significantly affect the activity of the added enzyme.

Example 1

A premix intended for poultry feed was prepared from the following ingredients:

	Weight %
Wheat flour	78.9
alfa-amylase	1.5
Protease	1.1
Cellulase with beta glucanase	18.5

The product was prepared according to the method depicted in the Figure and described above. This premix was relatively dry, stable and free flowing with a final moisture content of about 8%.

Examples 2-6 set forth various premix compositions which all were prepared on a commercial scale by the method depicted in the Figure and described above. All the carriers used in these examples contained water

e.g., the wheat flour used contained between about 13% and about 14% water by weight.

Example 2

Ingredients	Weight %	Weight % of final product
Cellulase with beta-glucanase (solution)	40%	27.5% of dry substance
Wheat flour	60%	72.5% of dry substance

Water content of ingredients 27%
Water content of final product 9%
(% are all by weight)

Example 3

Ingredients	W ight %	Weight % of final product
Cellulase with beta-glucanase (solution)	13.9%	8.8% of dry substance
Neutral protease (solution)	3.0%	2.1% of dry substance
Glucoamylase (solution)	4.4%	1.7% of dry substance
Alfa-amylase (dry)	1.3%	1.6% of dry substance
Wheat flour	77.4%	85.6% of dry substance

Water content of ingredients 21%
Water content of product 9%
(% are all by weight)

Example 4

Ingredients	Weight %	Weight % of final product
Cellulase with beta-glucanase (solution)	14.4%	8.8% of dry substance
Cellobiose (solution)	2.7%	1.6% of dry substance
Xylanase (dry)	0.9%	1.1% of dry substance
Wheat flour	82.0%	88.5% of dry substance

Water content of ingredients 18%
Water content of product 9%
(% are all by weight)

Example 5

Ingr dients	Weight %	Weight % of final product
Cellulase with beta-glucanase (solution)	8.2%	5.5% of dry substance
Cellobiose (solution)	8.2%	5.5% of dry substance
Neutral protease (solution)	9.5%	6.9% of dry substance
Acid protease (dry)	7.0%	9.3% of dry substance
Alfa-amylase (dry)	2.5%	3.3% of dry substance
Glycoamylase (solution)	8.2%	3.3% of dry substance
Wheat flour	56.4%	66.2% of dry substance

Water content of ingredients 5%
Water content of final product 9%
(% are all by weight)

Example 6

Ingredients	Weight %	Weight % of final product
Cellulase with beta-glucanase (solution)	15.3%	9.9% of dry substance
Neutral protease (solution)	4.3%	3.1% of dry substance
Alfa-amylase (solution)	6.0%	2.3% of dry substance
Wheat flour	74.4%	84.7% of dry substance

Water content of ingredients 23%
Water content of product 9%
(% are all by weight)

The premixes of Examples 1-6 were relatively dry, thermally stable, had good flow properti s, were easy to handle and can b simply and uniformly blended into a feed mix and can be prepared on a commercial scale according to the method aspect of this invention. Addition of the premixes to feed resulted in a final feed product with improved value and efficiency.

Example 7

In order to demonstrate the effectiveness of an enzyme premix, a group of broiler poultry was given feed which did not utilize the enzyme premix of this invention and comparisons were made to groups of broiler poultry which were utilizing an enzyme premix of this invention.

The results of these tests are set forth in Table 1 below.

Table 1

	Group I	Group II	Group III
Feed	Wheat	Barley Premix 1	Barley Premix 2
Calculated energy MJ/kg feed	12.4	12.4	12.4
Weight grain (g)	1714	1743	1693
Consumption (g)	3153	3195	3394
Conversion rate	1.84	1.83	2.00

In this test, each group consisted of 100 broiler chickens fed with the experimental mixes for 42 days. Group I was fed with wheat feed which did not contain any enzyme premix. Group II was fed with a barley feed which contained the enzyme premix of Example I, and Group III was fed with a barley feed which contained the enzyme premix of Example 2. Barley was chosen for this test because it is well known in the art that poultry cannot utilize barley as effectively as they can utilize wheat. Barley feed is, therefore, rarely used for chickens.

The results of the test demonstrate that the barley feed products containing the enzyme premix were effective feeds, comparable to the wheat feed which did not contain the premix. Therefore, the enzyme premix, when added to the feed during processing, increases the value and efficiency of a barley based feed and makes this feed suitable for poultry, something which heretofore was not possible.

The following general discussion and experimental examples are illustrative of the present invention, and variations within the scope of the invention are possible as will be apparent to those skilled in the art.

Claims

1. A relatively dry, thermally stable, feed premix consisting essentially of a pelletized physiologically acceptable carrier and one or more enzymes.

2. A feed premix as claimed in claim 1 wherein the carrier comprises between about 40% to about 60% by weight, and the enzyme or enzymes comprise about 1% to about 60% by weight, of the premix.

3. A feed premix as claimed in claim 1 or 2 wherein the moisture content is less than about 10% by weight.

4. A feed premix as claimed in claim 1, 2 or 3 wherein the carrier is a grain flour.

5. A feed premix as claimed in claim 4 when the carrier is wheat flour or barley flour.

6. A feed premix as claimed in any preceding claim wherein the or each enzyme is selected from starch hydrolyzing enzymes, amylases, cellulose hydrolyzing enzymes, celluloses, hemicellulases, glucanses, lipases and proteinases.

7. A method for producing a relatively dry, thermally stable, premix comprising the steps of:
mixing a physiologically acceptable carrier with one or more enzymes;

reacting the carrier/enzyme mixture in a suitable vessel so that the enzyme or enzymes present are substantially absorbed into the carrier; and
pelletizing the reacted carrier/enzyme mixture.

8. A method as claimed in claim 7 wherein the particles of the dried premix are crushed or milled.

9. A method as claimed in claim 7 or 8 wherein the or each enzyme is added in aqueous solution.

10. A method as claimed in claim 7 or 8 wherein the or each enzyme is added in substantially dry in form.

11. A method as claimed in any one of claims 7-10 wherein the reacted carrier/enzyme mixture is dried to a moisture content of less than about 10% by weight.